Final Technical Report
for the
Office of Naval Research
Grant No. N00014-93-1-0441

Submitted by
The Center for Coastal Studies
Provincetown, Mass.

October 1994

Introduction

The Office of Naval Research under grant number N00014-93-1-0441 provided support to the Center for Coastal Studies for the purchase of equipment and software to aid in the development of field and laboratory protocols for the studying the behavior of large whales. Here we report on progress in the development of techniques associated with the study of whale behavior in combination with the collection of data on the movement patterns of whales, human activities, and oceanographic conditions, a Multivariable Collection Protocol or MCP. The focus of this report is the development of field and laboratory techniques to determine the variables, to design a protocol for field collection, to apply the real time sonagraphic software to collected vocalizations, and to develop a simplified catalog of sounds. The field and laboratory protocols were developed to (1) permit the simple and inexpensive collection of descriptive information surrounding each observation, (2) yield an analysis which would either suggest or confirm the relationship among the selected variables of the many which affect whale behavior, and (3) provide baseline information on the variables permitting a detailed comparative analysis of whale behavior.

Specifically, the equipment purchased under the grant was intended to support the development of the field protocols for (1) documentation of whale vocalizations and (2) management of all incoming data via data loggers. Additional equipment and software was purchased for laboratory analysis of vocal behavior and for integration of observations and analysis using statistical package. This report, therefore is focused on audio documentation, the development of simple field synchronization techniques, and, particularly, on the application of real time sonagraphic software to the development of a simple key - based catalog of sounds.

Field Collection

For the development of the MCP we chose to collect information on the right whale both because this species is poorly understood and because the severely depleted condition of the population makes an understanding of the activity patterns of the species of paramount conservation significance.

Cape Cod Bay, the area where our studies have been ongoing since 1984, has long been known as a habitat where right whales feed and socialize in the winter and early spring. The Bay, therefore, was recommended in the Final Recovery Plan for the Northern Right Whale (*Eubalaena glacialis*) (National Marine Fisheries Service, 1991) for designation as a critical habitat and so declared in the summer of 1994. Each year since 1984 we have observed as many as 50 right whales in Cape Cod and Massachusetts Bays, primarily in the winter and early spring, feeding and caring for their young (Hamilton and Mayo, 1990). The eastern part of the embayment where small groups of right whales actively feed at or near the surface is particularly rich in seasonally abundant phyto- and zooplankton resources which may attract the whales to the region. In this area of the eastern Bay we documented the surface activity of groups of socializing whales and while collecting basic information on the food resources of the area for combination with data on the vocalization of the whales and information on vessel movement. To develop and test documentation techniques we collected synchronized video and audio recordings coupled with data logging of oceanographic and biological information. Of these observations, we concentrated our development efforts on two particularly rich (and, therefore, challenging from a data management perspective) video-audio segments and associated documentation collected on 26 March 1993 and 31 March 1993, a total of 1.9 hours in duration. The behavioral information was combined with data from oceanographic observations and collections of zooplanktonic foods to yield a raw data set available for analysis.

Laboratory Analysis

In the laboratory, we developed the functional interfaces between the DAT recorder used for field recording of underwater sounds, an analog tape player/recorder used for creating working sound sources, a 486/33 PC running Real Time Sonagraphic (RTS) software obtained from Engineering Design, Belmont, MA, and a laser printer. Using these systems it was possible to operate the audio tape and the RTS side-by-side permitting the running display of individual audio event spectrograms vs. time and comparing these with behaviors available from a data logger running event recording software developed at CCS. It was also possible to run video segments synchronized with the audio record and RTS sonagraphic display to demonstrate the association between observed surface behavioral events and the acoustic record. Through the use of the event and data recording software, we were able to thereby associate the disparate data bases (see figure 1) from several sources to create the prototype Multivariable Collection Protocol.

Variables

The variables selected for documentation fell into the broad database categories listed in figure 1. For the purposes of this contract, th . f our development effort was the design of a system for recording and analyzing wh . vocalizations compatible with the documentation techniques used for the collection of dat. for other databases. It was necessary, therefore, to create a collection technique (see below) which permitted the construction of a real - time comparison of incoming sounds with other databases and to initially categorize and process the acoustic information according to simple catalogs to demonstrate that vocal activity could be documented and compared to other data streams. Fundamental to this approach was the development of methods for application of the Real Time Sonagraphic software (Engineering Design, Belmont, MA) to collected data. Subsequently, with RTS running, we proceeded to collect sonograms of right whale vocal activity analyzed from time synchronized audio and video tapes for the purposes of developing a simplified catalog of vocalizations. Development of the components of the vocalization study were accomplished with the aid of several interns and staff members: Margaret Murphy (field recording techniques), Janet Doherety (RTS use), and Dara Wambach and Nicky Spencer (cataloging).

Results

Examples of the simple descriptive techniques used for the MCP audio database are given in Appendices I and II. The numerically described type sounds are exemplified by the first 10 sonograms in Appendix III and described in Appendix IV.

In addition to the development of a simplified, hierarchical catalog, the collation of data from one observation is presented in the example found in Appendix V.

Continued Work

The development started with the protocols described here will continue to focus on the streamlining of field data collection from the variety of different sources. In particular, we are endeavoring to streamline the field logging by employing pen-based computers

MCP: databases and sources

- Behavioral Observations (video to data log)
- Vessel Activity (direct data log)
- Vocal Behavior (hydrophone to tape to log)
- Orientation (direct data log)
- Oceanographic Data (direct CTD log)
- Biological Data (hand record; field collection)
- Environmental Observations (hand record)
- Demographics/Genetics (photo to catalogs)
- Historic Data (photo to CCS/NEA database)

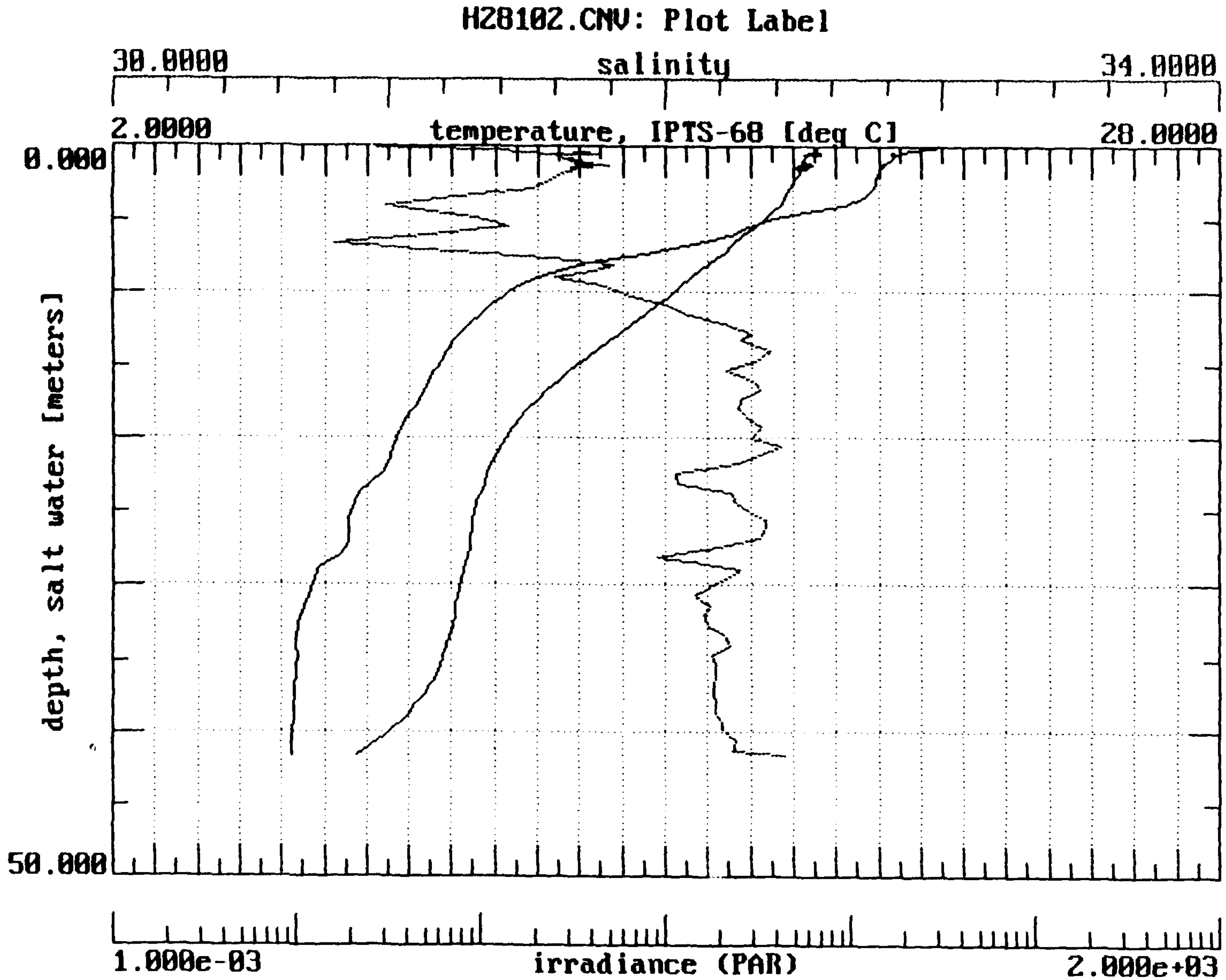
Figure 1

and programs which mimic those used to date but which do not require key entry. Further incorporation of more complete catalogs of both vocal and surface behaviors and the development of similar descriptions for other species of marine mammals also will be the focus of future work. At its present level of development, we have begun to use MCP to develop a database for the assessment of the effects of environmental conditions on whale behavior in the Stellwagen Sanctuary and the Cape Cod Bay Critical Habitat.

Applications

Although still in the development stage, this holistic approach to the development of baseline data for the documentation of the principal effecting variables influencing the behavior of whales offers considerable promise. Because this documentation protocol is based on simple and inexpensive techniques, the collection of the volume of data needed to develop the baseline information for comparative studies is possible. Further, the template which this protocol suggests includes a variety of oceanographic and environmental parameters which permit the placement of the behavioral observations in the larger context of the observations.

The applications of a holistic, multidisciplinary approach to field behavioral observations are many. Generally these techniques, with the extensive baseline data to support them should considerably improve our ability to design the comparative studies critical to our understanding of the activities of whales in the ocean system and the influences on them. A variety of study areas are suggested: (1) measurement of important characteristics of critical habitats, (2) determination and modeling the effects of a wide variety of human activities on marine mammals, (3) investigation of questions involving the social character of whale populations, and (4) characterization of basic behavior patterns such as foraging, social interaction, and nursery in the context of environmental conditions.


H28102.CNV: Plot Label
30.0000
salinity
34.0000
2.0000
temperature, IPTS-68 [deg C]
28.0000
0.000
depth, salt water [meters]
50.000
1.000e-03
irradiance (PAR)
2.000e+03

Appendix I

Right Whale Vocalization: Proposed Taxonomic Structure

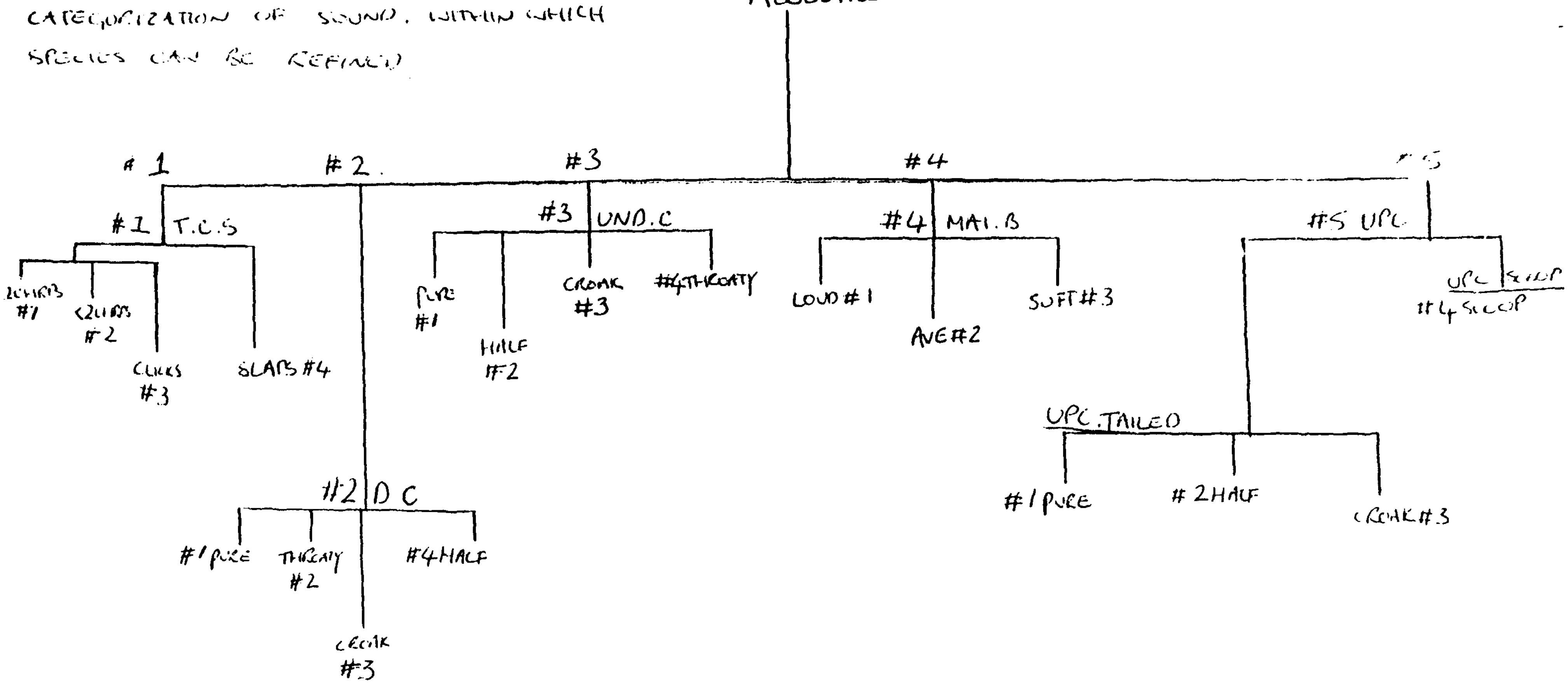
by

Nicky Spencer

HALL'S REVISED SPEC.

KEY WITH WHICH TO ESTABLISH BROAD CATEGORIZATION OF SOUND, WITHIN WHICH SPECIES CAN BE REFINED

RIGHT WHALE ACOUSTICS



#	SUBORDER
1.	TOGETHER CALLS. SLAPS
2.	DOWN CALL
3.	UNDULATING CALL
4.	MAINTENANCE. BLOW
5.	UPCALL — UPC SCOOP UPC TAILED.

HALOS H25C B SIDE 1

TOGETHER CALL SLAPS (T.C.S) IS SUBORDER #1 CONSISTING OF WHAT WERE PREVIOU[illegible] CLASSED AS LOW CALLS. SOUNDS THAT APPEAR TO BE ~~[illegible]~~ LINKED SUCH AS SMALL CLICKS.

TOGETHER CALLS FAMILIES CONSIST OF (2 CHIRPS) #1 (<2 CHIRPS) #2 + CLICKS #3. SLAPS.

TYPES CALL FOR T.C IS ~~[illegible]~~ 196 : FILENAME L112TC1M.196

[illegible] T.C.S [illegible]

#1 (2 CHIRPS)

TYPE

198   261   111

274/5   340   437

549   635   661

#2 (<2 CHIRPS)

453 ← buzzing sound

448

443

#3 CLICKS [illegible]

[illegible]   [illegible]

[illegible]   5[illegible]4

[illegible]   [illegible]

[illegible]   [illegible]

635   [illegible]

[illegible]   663

269/70   635

462[4]

[illegible] #[illegible]

[illegible]

HALOS H250B SIDE 1

DOWN CALL (D.C) IS SUBORDER NO. 2 CONSISTING OF A GROUP OF UNDIFFERENTIATED CALLS THAT ON A [illegible] SCALE OF FREQ/TIME RUN A HIGH-LOW GENERAL COURSE. DOWN CALL FAMILIES CONSIST OF: PURE, #1, THROATY #2, CROAK #3 ½ CROAK ½ PURE OR HALF #4.

THE TYPE CALL FOR DOWN CALLS IS 470. IT IS OF THE FAMILY HALF.

FILENAME: L24OCH1H.470

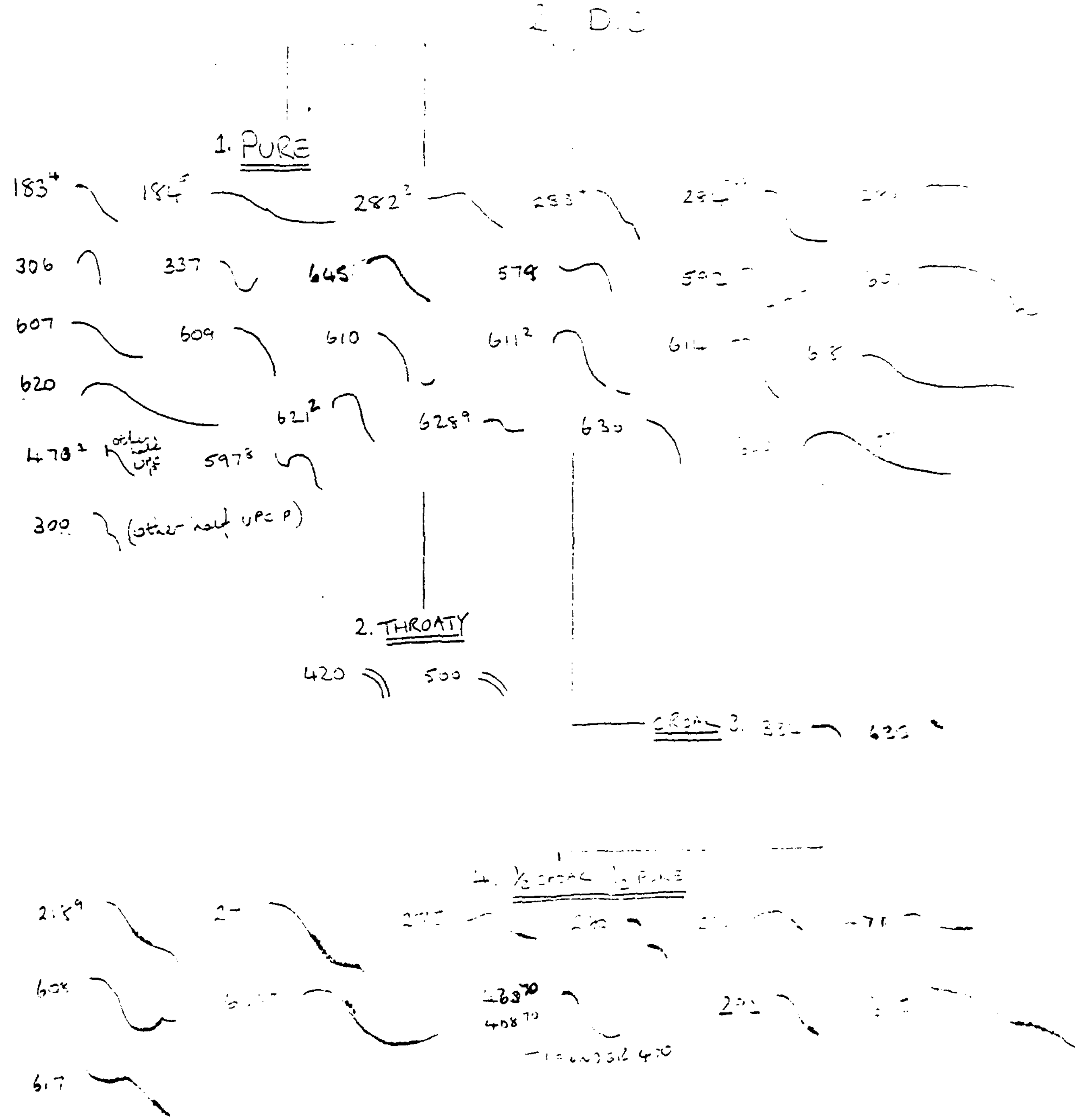
SUBORDER #

FAMILY #

470: FREQ AS SOUND BEGINS: 859.38

ENDS: 781.25

DURATION: 0.311 SECS.



HALOS H25C 15 SIDE 1.

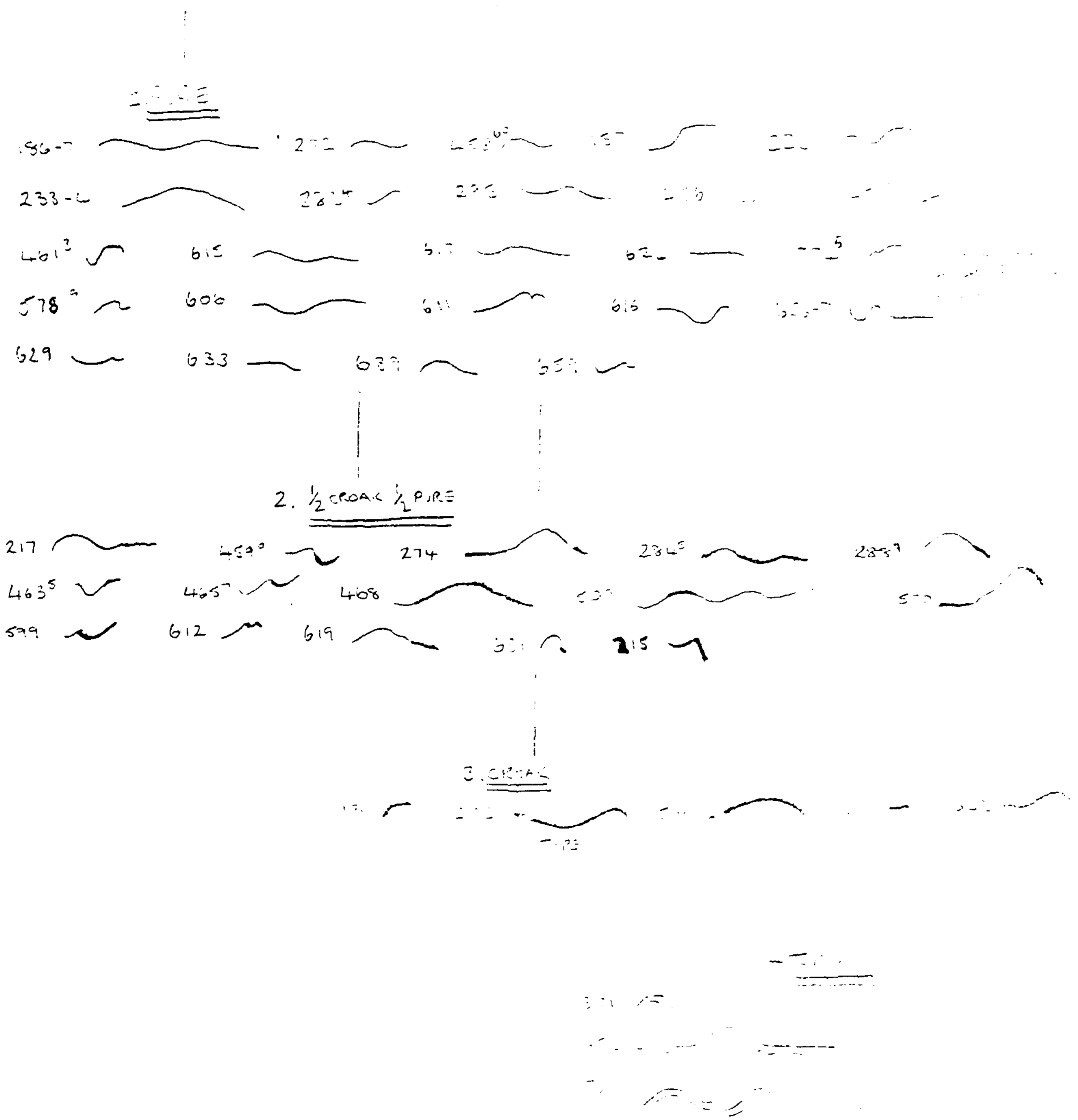
UNDULATING CALL (UND.C) IS SUBORDER #3 CONSISTING OF A LARGE UNDIFFERENTIATED GROUP OF CALLS THAT ON A [illegible] FREQ/TIME SCALE RUN ON A RELATIVELY FLAT COURSE WITH ~~[illegible]~~ RISES + FALLS IN FREQUENCY. ~~[illegible]~~ UNDULATING CALL FAMILIES CONSIST OF: PURE #1, HALF #2, CROAK #3, THROATY #4

THE TYPE CALL FOR UNDULATING CALLS IS 273. IT IS OF THE ~~FAMILY~~ CROAK.

FILENAME: L33UNC1H.273

SUBORDER # FAMILY #

273. FREQ AS SOUND BEGINS: 656.25
" " " ENDS: 765.63
DURATION: 1.375 SEC.



HALOS H2506 SIDE 1

MAINTENANCE. BLOW (MAI.B) IS SUBCODER #4.

FAMILIES: LOUD BLOW #1
AVERAGE BLOW #2
SOFT BLOW #3

TYPE CALL : 124 

FILENAME : L42BLA1H.124

4. MAI.B

1. LOUD BLOW

STANDARD NOTATION

198, 630-1
632, 634
644,

2. BLOW

STANDARD NOTATION

183, 176, 208
229, 290, 253,
267, 272, 280
298, 303, 310
315, 333, 455
460, 463, 472
478, 573, 578 9
592, 648
660 within other sound
124 TYPE

3. SOFT BLOW

STANDARD

191, 379 602,
626, 628, 6-8
344

MALOS H25GB S.06 1.

UP CALL (UPC) IS SUBORDER #5 CONSISTING OF A GROUP OF UNDIFFERENTIATED CALLS THAT ON A CRUDE SCALE OF FREQ/TIME RUN A GENERAL LOW – HIGH COURSE. UP CALL FAMILIES CONSIST OF: PURE #1, HALF #2, CROAK #3 AND A MORE DISTINCT GROUP OF SCOOP#4 CALL THAT ALL SOUND PARTICULARLY LOW AND SHORT.

PURE, HALF AND CROAK ARE UPCALL TAILED TYPE 220. FILENAME: L520UPHIH.220

SCOOP: UPCALL SCOOP TYPE 229. FILENAME L54USC1H.229

UPC TAILED: FREQ AS SOUND BEGINS: 113.28
" " " END: 373.91
DURATION: 1.593 SECS

UPC SCOOP: FREQ AS SOUND BEGINS: 179.[illegible]
" " END: 449.[illegible]
DURATION: 0.914 SECS

5. [illegible]

1. PURE

108 110 210 224 225 23

282 348 463 465[7] 57[illegible]5

576 588 627-8 644

644-5 647 663 292 300

213 473 4624 663 574[3]

2. ½ CROAK ½ PURE

211 216[4] 220[1/2] TYPE 228

244 265 269[?]

276 277[3] 336 422

506[?] 604

3. CROAK

173 207 33[?] 4[?]

54[7] 5[?] 5[?]

635

229 TYPE

30[?] 303

501

Appendix II
Right Whale Vocalization: Examples of Types
by
Nicky Spencer

Right W 'e Sound

Trip-Tape-Side-Counter
I250B. 1 - 1 - 220

~~4kHz~~ 8kHz Other: 2500 Hz Use setup SAMPLE RATE Hz
(circle one)

Type Sound: FOR SUBORDER : UPCALL FAMILY : 1/2 crack 1/2 pure or Half

Saved name (log##type#h.ctr)
c:\signal\rw\ L52 UPH1H . 220

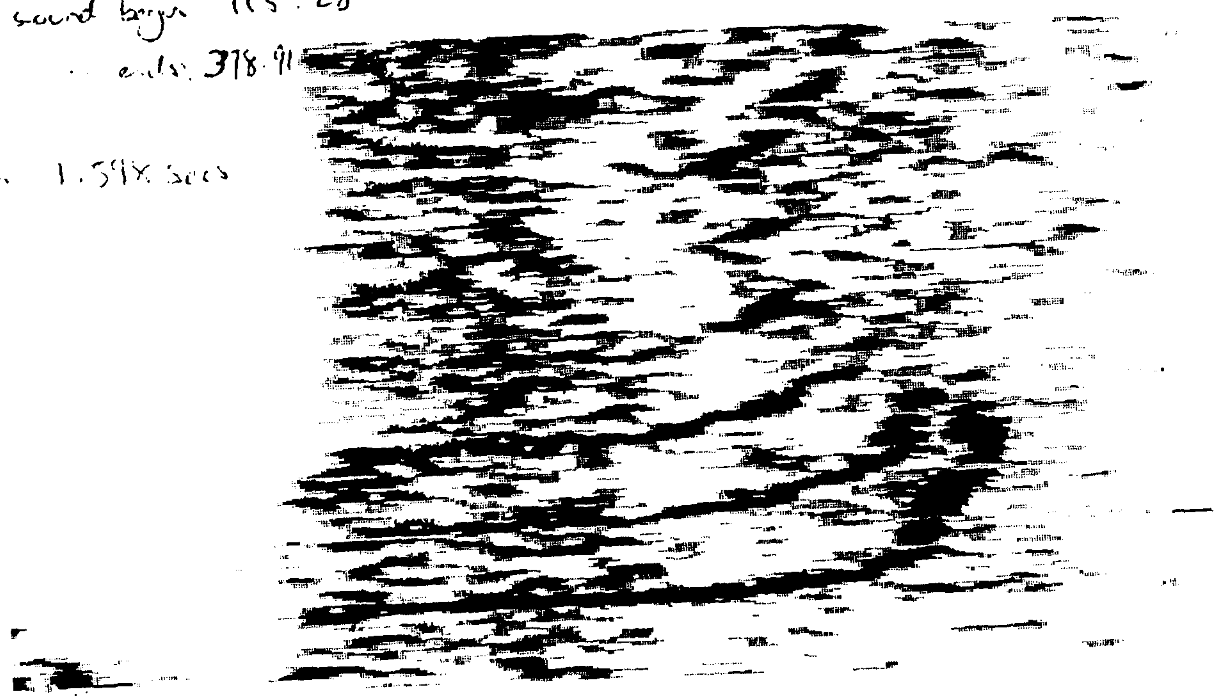
logfile:______

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:______

freq. as sound begin 113.28
ends 378.91

Duration 1.59X secs



Right Whale Sound

Trip-Tape-Side-Counter H25C3 - 1 - 229

4kHz 8kHz Other:________
(circle one)

Type Sound: low tonal up call

Saved name (log##type#h.ctr)
c:\signal\rw\ L57 UC 8h.229

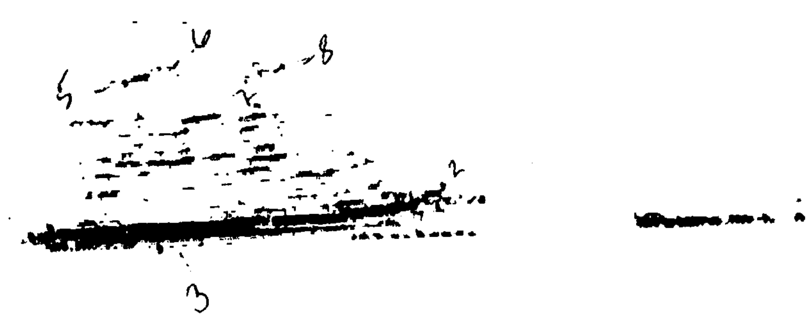
logfile: RW,6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: Eg type 2 (log 31)

freq/time notation

TYPE CALL FOR 'UP CALL SE...'



Right Wh'e Sound

Trip-Tape-Side-Counter
H25OB - 1 - 1 - 124

4kHz 8kHz Other: 2500 Hz Upsample SAMPLE RATE
(circle one)

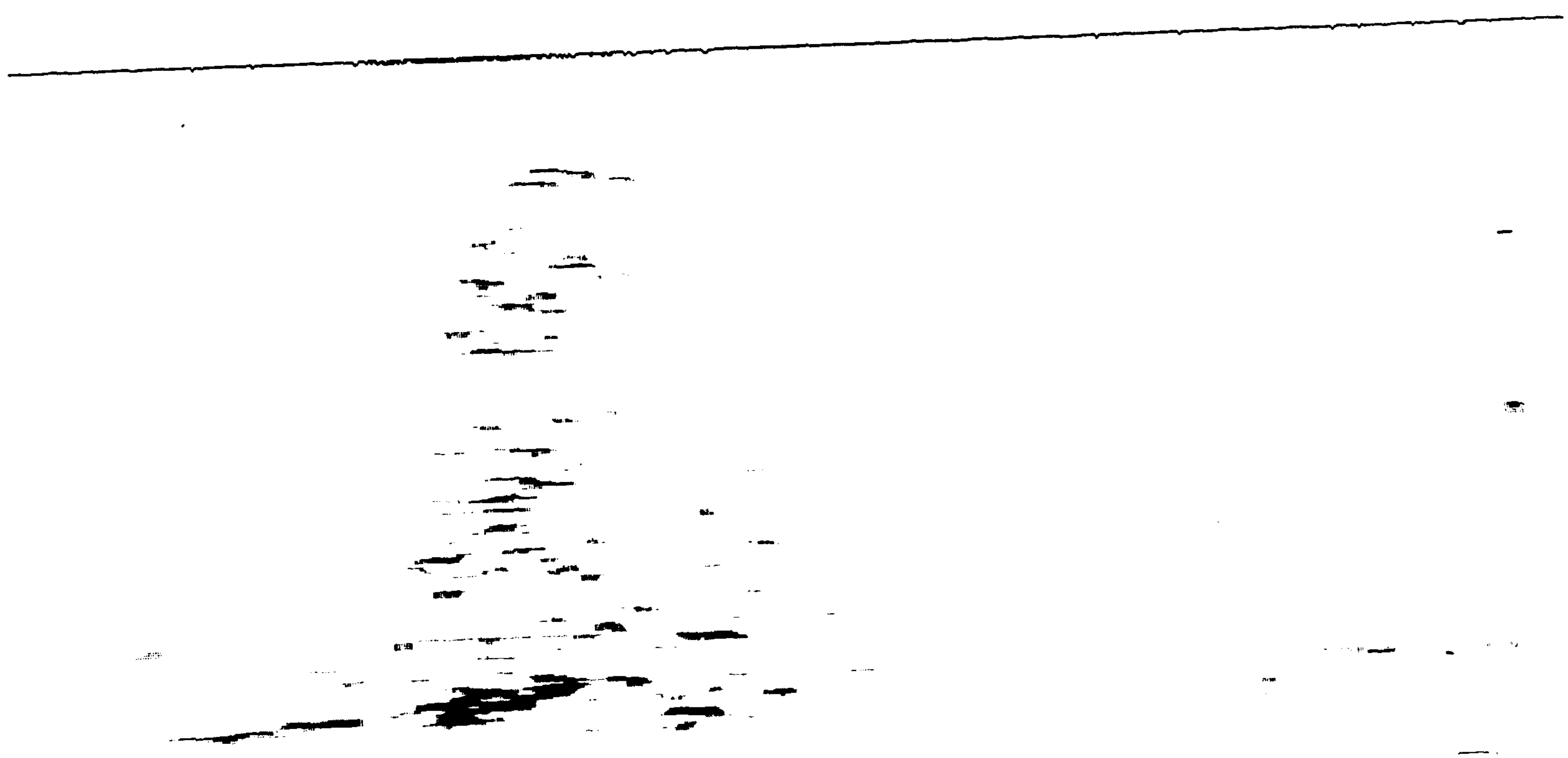
Type Sound: GR SUBSERIES HAWK FAMILY ROW, AVERAGE

Saved name (log##type#h.ctr)
c:\signal\rw\ L42BLA1H 124

logfile:______

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:______



Righ Vhale Sound

Trip-Tape-Side-Counter
H25CB- 1 - 1 - 229

~~4kHz~~ ~~8kHz~~ Other: 2500 Hz   U(sec x freq) SAMPLE RATE Hz
(circle one)

Type Sound: FOR: SUBORDER . UP CALL
FAMILY . SCOOP

Saved name (log##type#h.ctr)
c:\signal\rw\ LS4 USC1h . 229

logfile:______

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz
1 Hz 2500 Hz

Comments:______

UP CALL
FAMILY : SCOOP
freq | have not been

Freq begin : 179.69
Freq end : 449.22
Duration : 0.914

Right 'hale Sound

Trip-Tape-Side-Counter 1996 - 1 - 1 - 229

4kHz 8kHz Other:________
(circle one)

Type Sound: low tonal up call

Saved name (log##type#h.ctr)
c:\signal\rw\L57 wc 4h.229

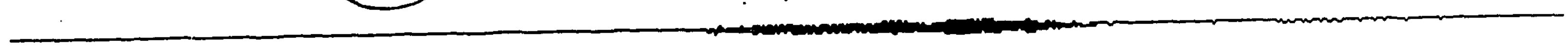
logfile: RW.6

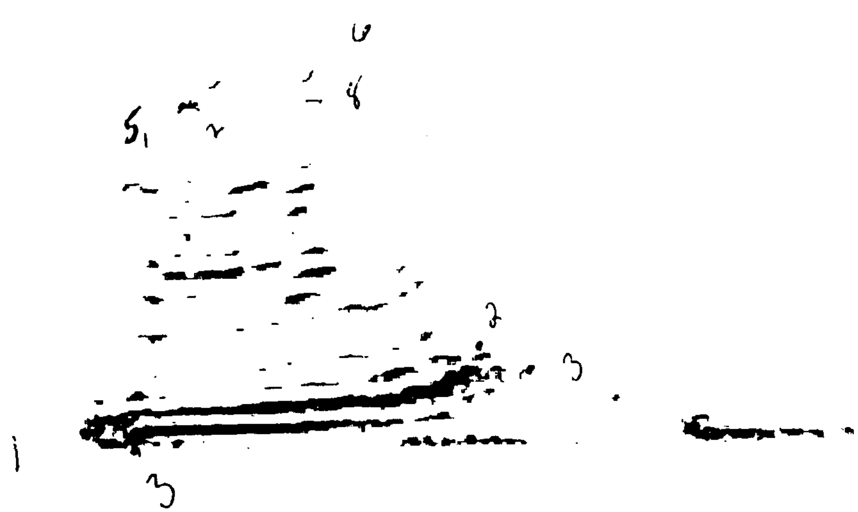
Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: Egtype 2, log #30

freq of time notation

TYPE CALLS FOR 'UP CALLS' SCOOP (KET). NS.





Right Whaie Sound

Trip-Tape-Side-Counter
- 1 - 1 - 195   196

4kHz 8kHz Other:________
(circle one)

Type Sound: low up - call

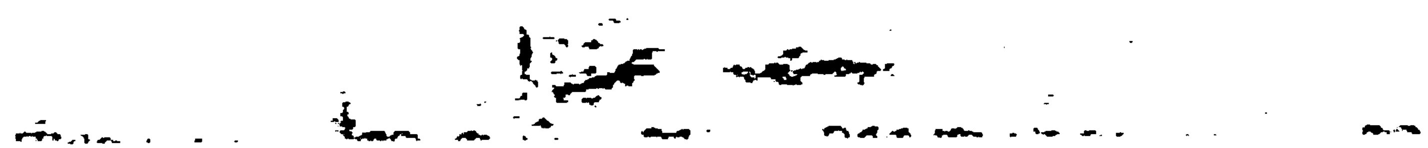
Saved name (log##type#h.ctr)
c:\signal\rw\ L50 LUC4h.195

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds.   scroll rate: 6.8 seconds.
spectral gain: -57.00 db   spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz   frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz   frequency resolution: 19.5 Hz

Comments: pulsive or tonal?

Play time rotation   TYPE FOR 'TOGETHER CALL' IN KEY. JS.   2 CHIRPS



Right W   le Sound

Trip-Tape-Side-Counter
- - - 220

4kHz 8kHz Other:________
(circle one)

Type Sound:______________

Saved name (log##type#h.ctr)
c:\signal\rw\ L55 huc 8h.220

logfile: RW.6

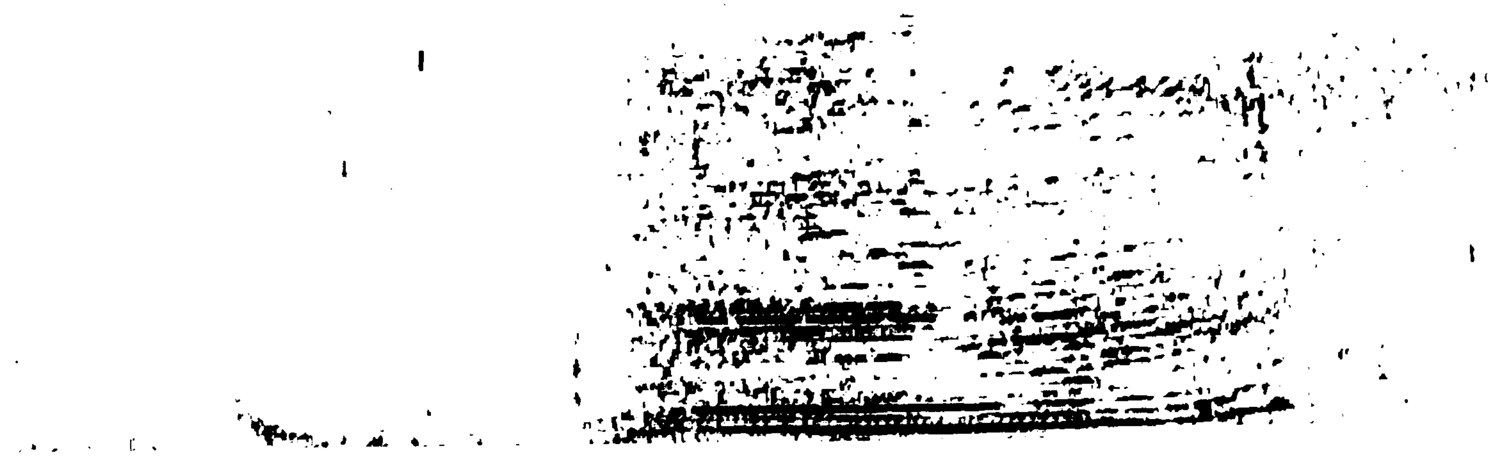
Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:

freq modulation

freq/time
freq modulation

TYPE CALL FOR 'UP CALL' 1/2 croak 1/2 pure. AS PREVIOUSLY CLASSED AS FULL CALL. NOW AS UP CALL UP CALLS MAY BE CROAKY, PURE OR 1/2 + 1/2 (on in this examp



Right Wl e Sound

Trip-Tape-Side-Counter
_ - _ - _ - 220

(4kHz) 8kHz Other:________
(circle one)

Type Sound: up

Saved name (log##type#h.ctr)
c:\signal\rw\ 555 nuc 4h.220

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: CANCEL "VP" designation
Pulsive constant.

UP CALL
FAKED

Freq rotation

Freq/time
Freq rotation
TYPE CALL FOR UP CALL ½ crack ½ pure. us

PREVIOUSLY CLASSED AS FULL
CALLS, NOW AS UP CALL

UP CALLS MAY BE !
CRCAK
PURE
OR ½ + ½ (AS IS THIS TYPE)

Right Whale Sound

TYPE ... FAMILY : 2 CHIRPS

Trip-Tape-Side-Counter
H250B-1 - 1 - 196 (195) CTR changes

4kHz 8kHz Other: 2500 Hz Use setup SAMPLE RATE Hz
(circle one)

Type Sound: FOR SUBORDER : TOGETHER CALL
FAMILY : 2 CHIRPS

Saved name (log##type#h.ctr)
c:\signal\rw\ ~~L11TC2.1~~
L112TC1H.196

logfile:______

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:______

Freq ~~at~~ as 1st sound begins : 308.59
Freq " ~~2nd~~ 1st sound ends . 417.97
Freq " 2nd " begins : ~~408.59~~ 414.06
" 2nd " ends 410.16

Duration sound 1 : 0.27 Secs
" " 2 0.327 Secs

Right W' 'e Sound

FAMILY HALF

Trip-Tape-Side-Counter
H250B - 1 - 1 - 470 (468 CTR CHANGES).

4kHz 8kHz Other: 2500 Usership SAMPLE RATE Hz
(circle one)

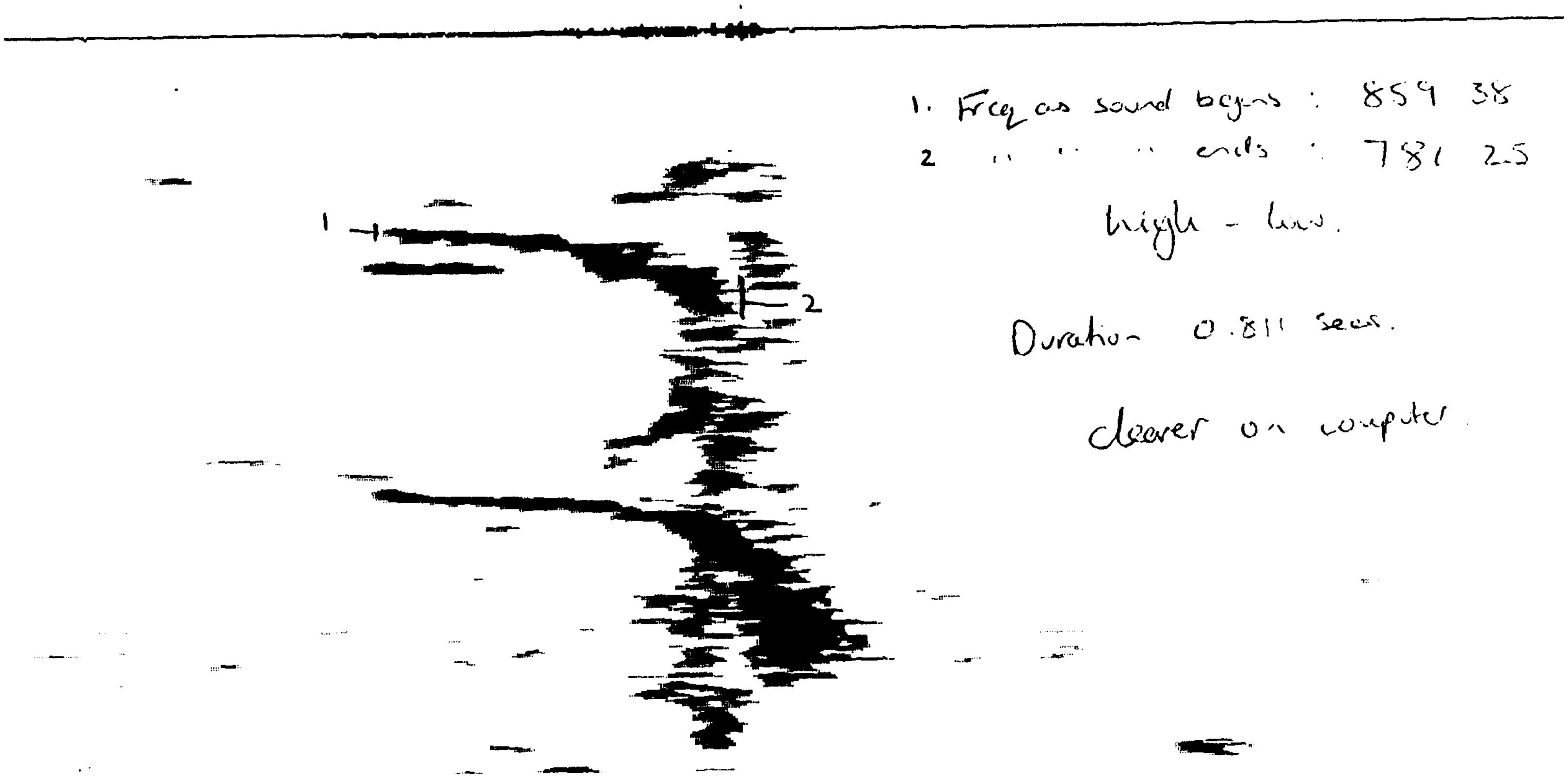
SUBORDER: DOWN CALL
Type Sound: [illegible]
FAMILY: HALF

Saved name (log##type#h.ctr)
c:\signal\rw\ L24 DCH 1H . 470

logfile:______

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:



1. Freq as sound begins : 859 38
2 " " " ends : 781 25

high - low.

Duration 0.811 secs.

clearer on computer

Right Whale Sound

Trip-Tape-Side-Counter
H250B 1 - 1 - 273

4kHz 8kHz Other:________
(circle one)

Type Sound: pulone

Saved name (log##type#h.ctr)
c:\signal\rw\ L63 PCA 8H.273

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: Eqtype, 2 log 15

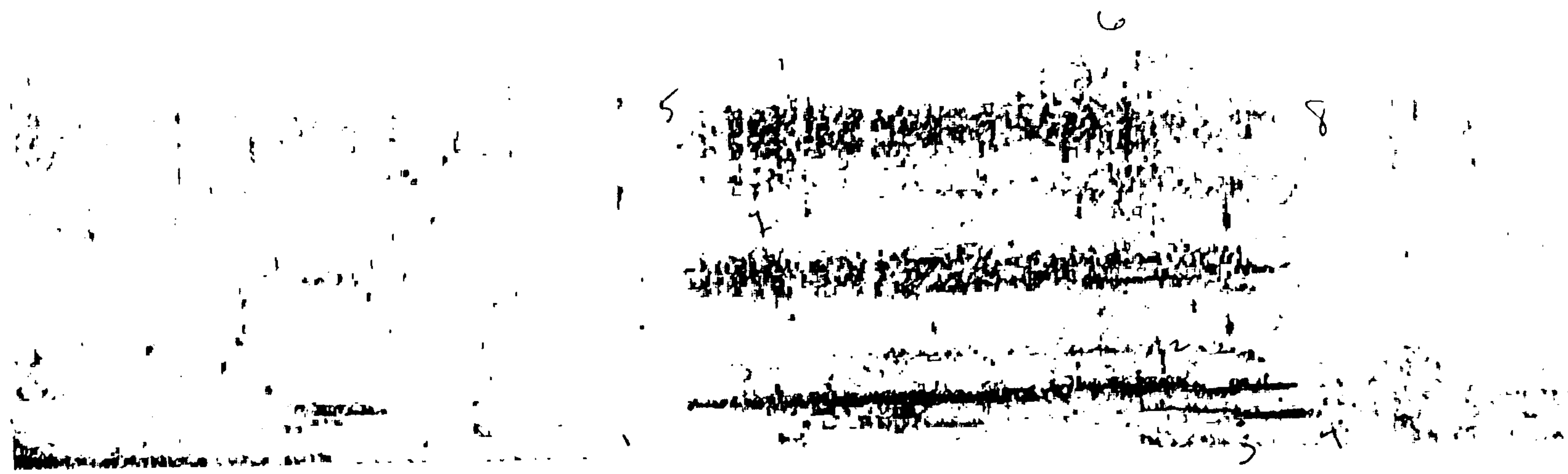
Freq/time notation

TYPE CALL FOR UNDULATING CALLS N3

MAY BE CROAKY PURE TONE OR 1/2 + 1/2

(UND CALL INCLUDE MOST FULL DIFFUSE CALLS)

THIS EXAMPLE IS CROAKY



Appendix III

Right Whale Vocalization: Examples of Type Vocalizations used in Numeric Descriptions

by

Dara Wambach

Right Whale Sound

Log 1

Trip-Tape-Side-Counter 1780 - 1 - 1 - 2[illegible]

4kHz 8kHz Other:________
(circle one)

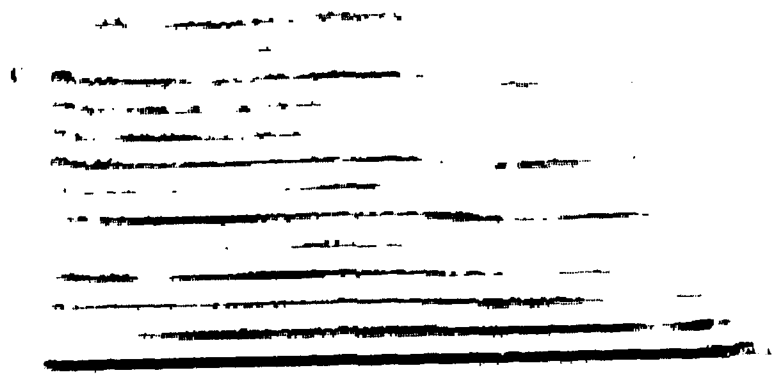
Type Sound: Str. call (unmod)

Saved name (log##type#h.ctr)
c:\signal\rw\ h355(a8h.294

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: logged @ 4kHz



Right Whale Sound

Trip-Tape-Side-Counter
HS - 1 - 1 - 294

4kHz 8kHz Other:________
(circle one)

Type Sound: Sk (wimmed) call

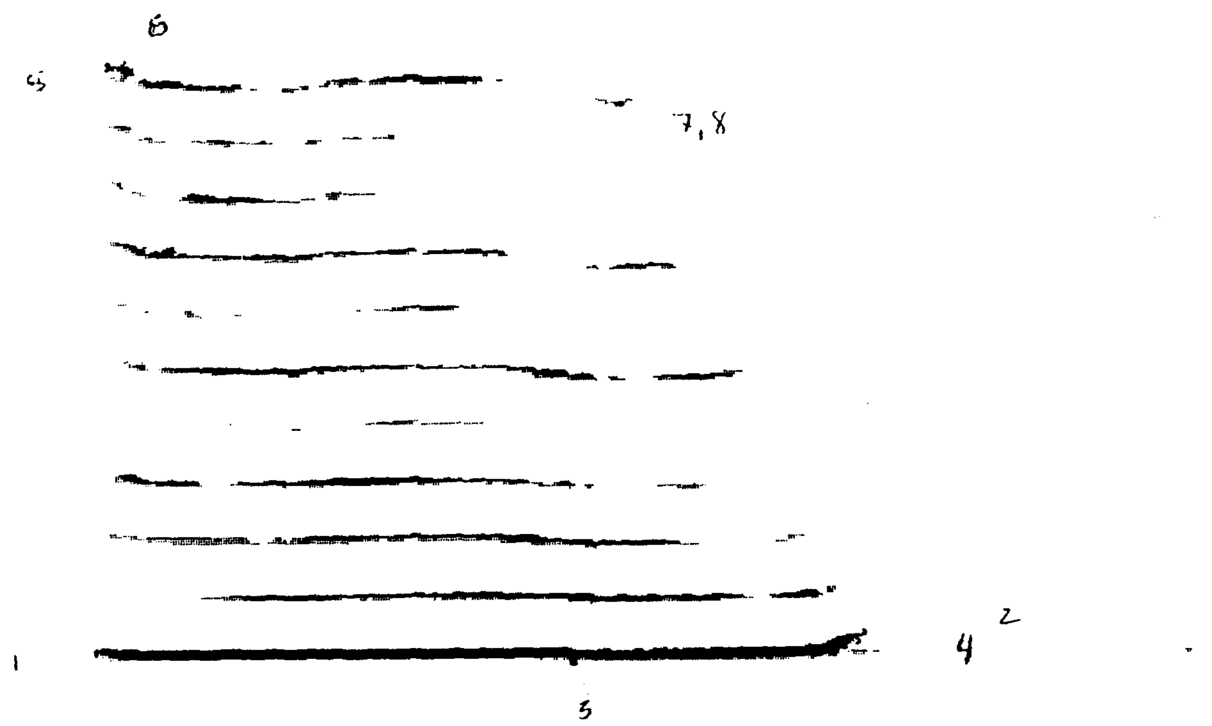
Saved name (log##type#h.ctr)
c:\signal\rw\ L35sk4h.294

logfile: RW.6

Log 2

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: relatively, some modulation
9
5 9 type 2, log #2



Right Whale Sound

Trip-Tape-Side-Counter - - - 281

4kHz 8kHz Other:________
(circle one)

Type Sound:______________

Saved name (log##type#h.ctr)
c:\signal\rw\L695h C 281

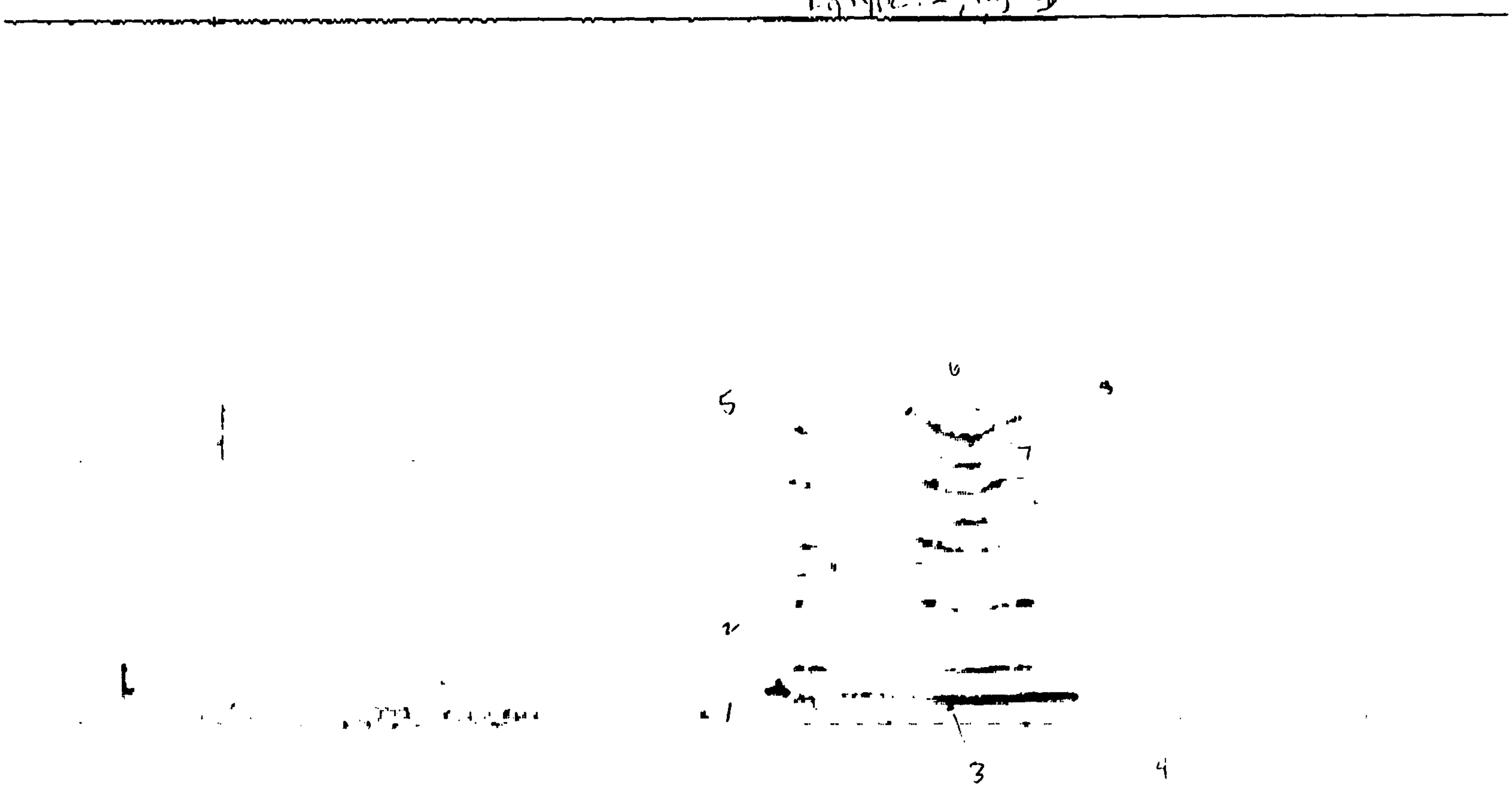
logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:

L-og 3

Eg type 2, log #



Right Whale Sound

Trip-Tape-Side-Counter
__ - __ - __ - 281

4kHz 8kHz Other:_______
(circle one)

Type Sound: short upcall

Saved name (log##type#h.ctr)
c:\signal\rw\l4shc4h 281

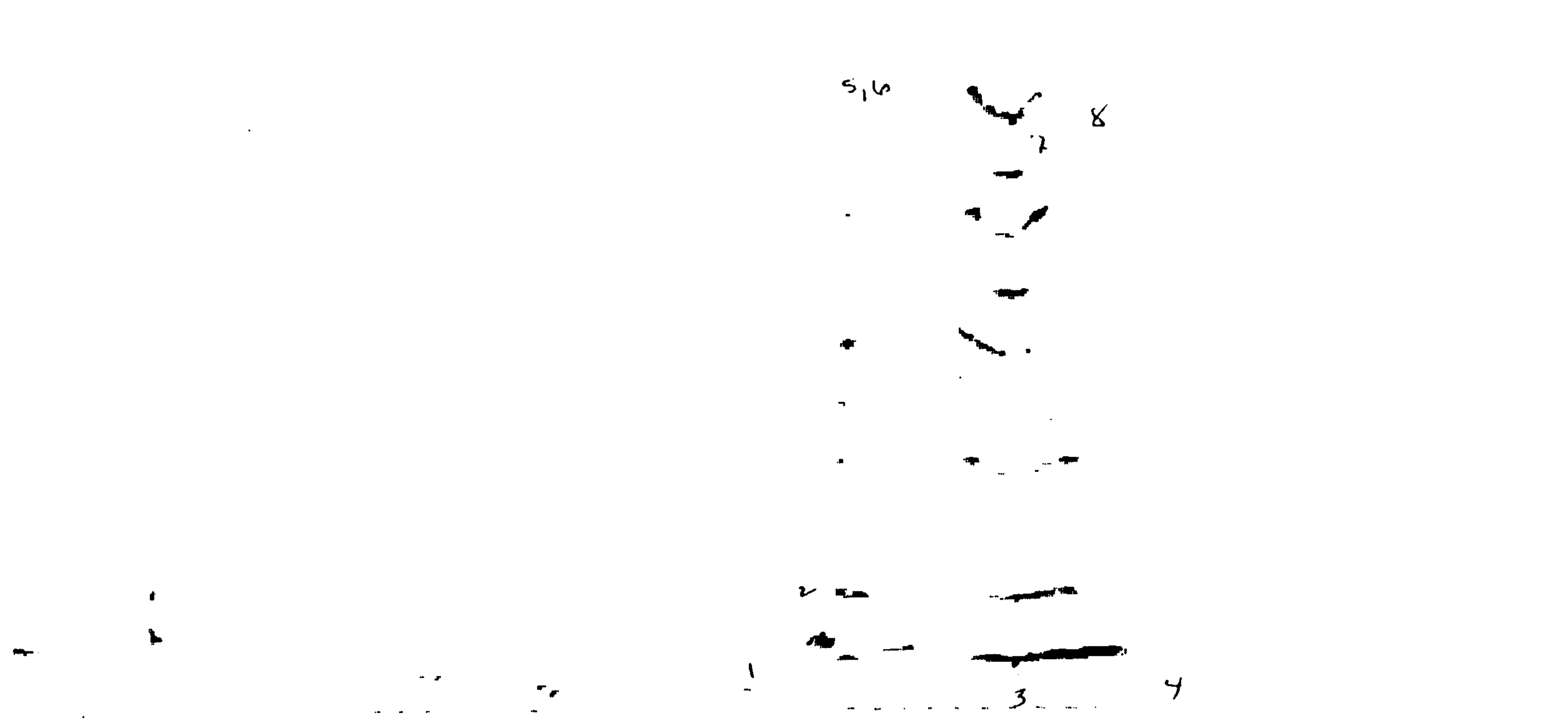
logfile: Rw6

log 4

Standard Settings for files:
length: 3.5 seconds.   scroll rate: 6.8 seconds.
spectral gain: -57.00 db   spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments:____________________________

Eg type 2, log 4



Right Whale Sound

Trip-Tape-Side-Counter
HRCB - 1 - 1 - 271

4kHz 8kHz Other:_______
(circle one)

Type Sound: high tonal

Saved name (log##type#h.ctr)
c:\signal\rw\ 261h1c6h271

logfile: RW 6

Log 5

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

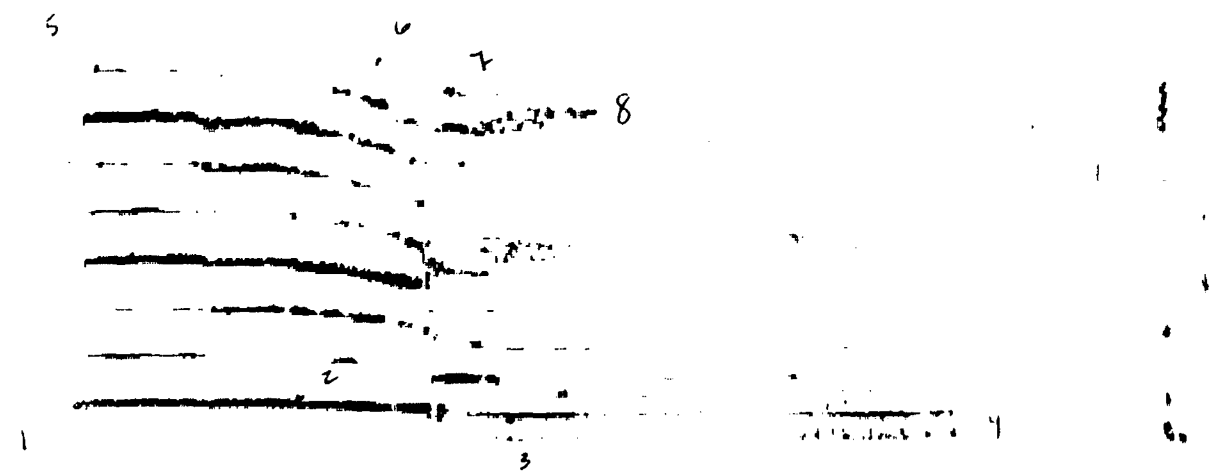
Comments: Ex type 2, log 5

~~freq time notation~~

~~TYPE CALL FOR DOWN CALL~~ (LIKE 1) NS

~~MAY BE CROAKY PURETONE~~ (ASK IS THIS EXAMPLE)

(NOT ~~ALL FULL~~ CALLS ARE ~~CLASSED AS DOWN~~ CALLED)



Log 6

Right Whale Sound

Trip-Tape-Side-Counter: 1125B-1-1-271

4kHz 8kHz Other:_______
(circle one)

Type Sound: High tonal

Saved name (log##type#h.ctr)
c:\signal\rw\ 1 6 c 1 1 c 4 H . 2 7 1

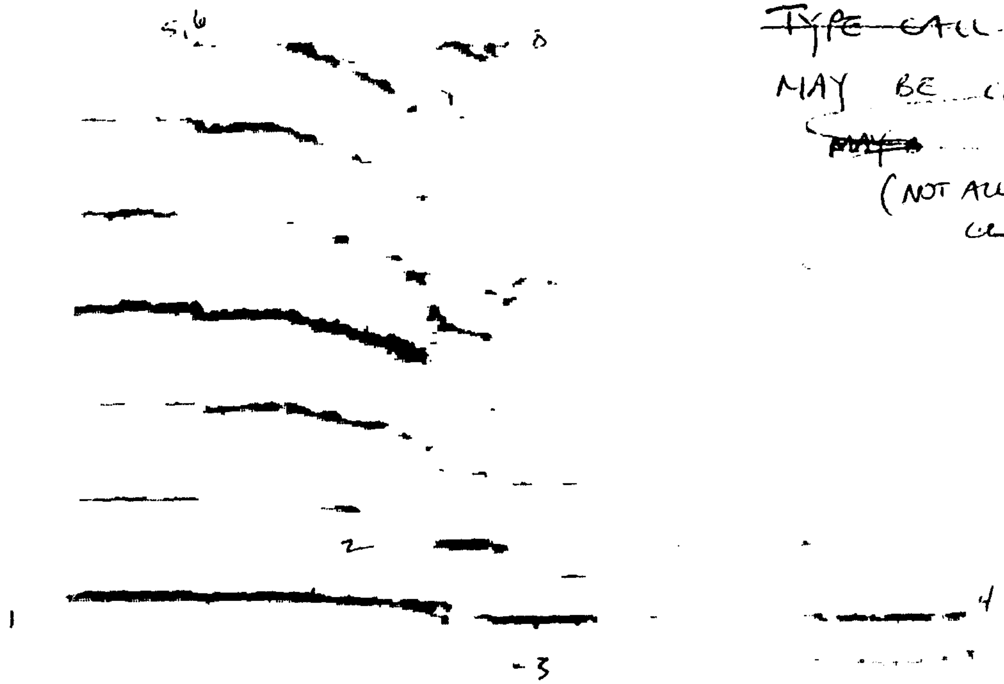
logfile: RW6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: this sound follows a similarly structured short sound at the beginning of a rich sequence of complex vocalizations - knife slap

Eg type. 2 log. 6 'note high harmonic is clear trills making looping parabolic

Freq / time



~~TYPE CALL FOR~~ 'DOWN CALL' (KEY)
MAY BE CROAKY, PURETONE, OR ½ ½ (as is this example)
~~MAY~~
(NOT ALL FULL CALLS ARE CLASSED AS DOWN CALLS)

Right Whale Sound

Trip-Tape-Side-Counter
#205 / - / - 218/9

4kHz 8kHz Other:________
(circle one)

Type Sound: mix mod call

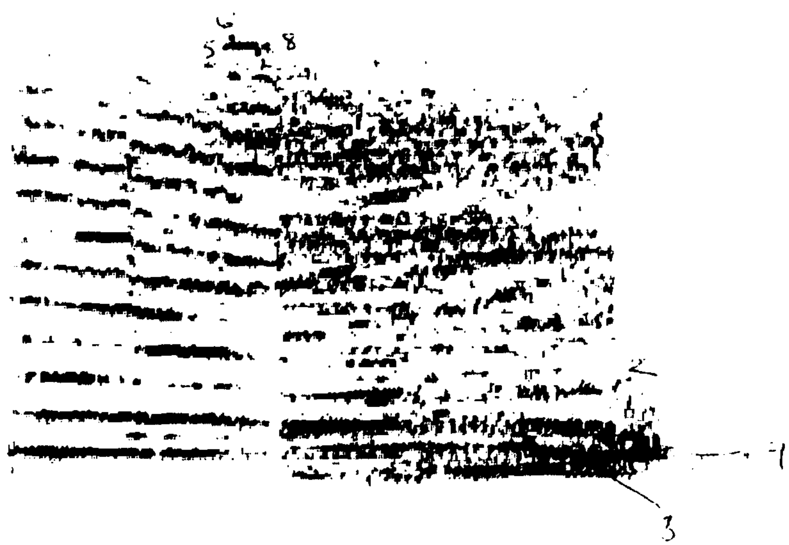
Saved name (log##type#h.ctr)
c:\signal\rw\ LS2Mmc8h.218/9 219

logfile: Rw.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Log 7

Comments: Eg type 2, Log 7



Right Whale Sound

Trip-Tape-Side-Counter
__ - __ - __ - 218

(4kHz) 8kHz Other:_______
(circle one)

Type Sound: Mix med

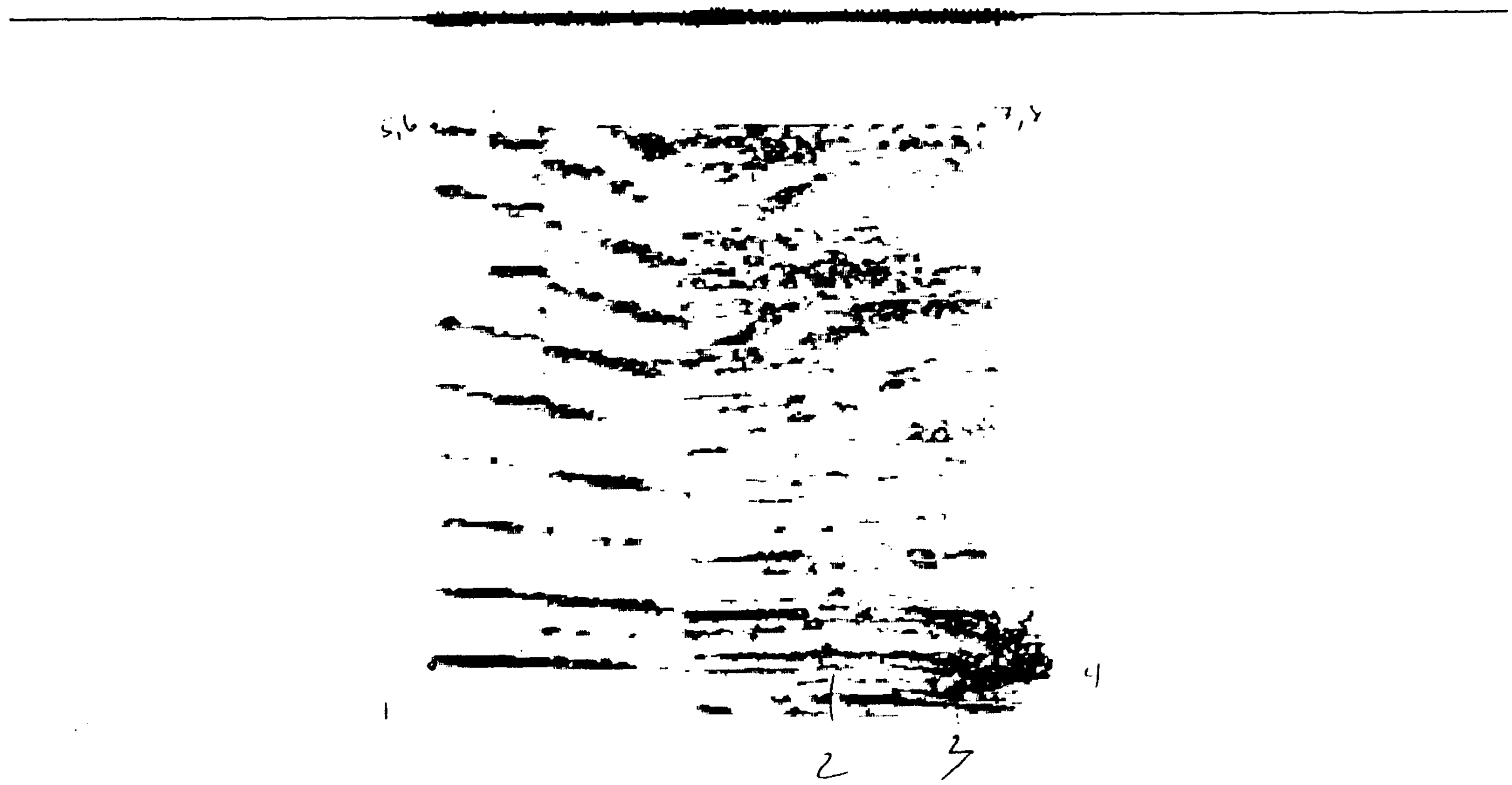
Saved name (log##type#h.ctr)
c:\signal\rw\ L54 mix 4/12 18

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Log 8

Comments: Eg type 2 log 8 Note higher than 4kHz see 8kHz for top



Right Whale Sound

Log 9

Trip-Tape-Side-Counter
H2S013 - 1 - 1 - 186

4kHz (8kHz) Other:________
(circle one)

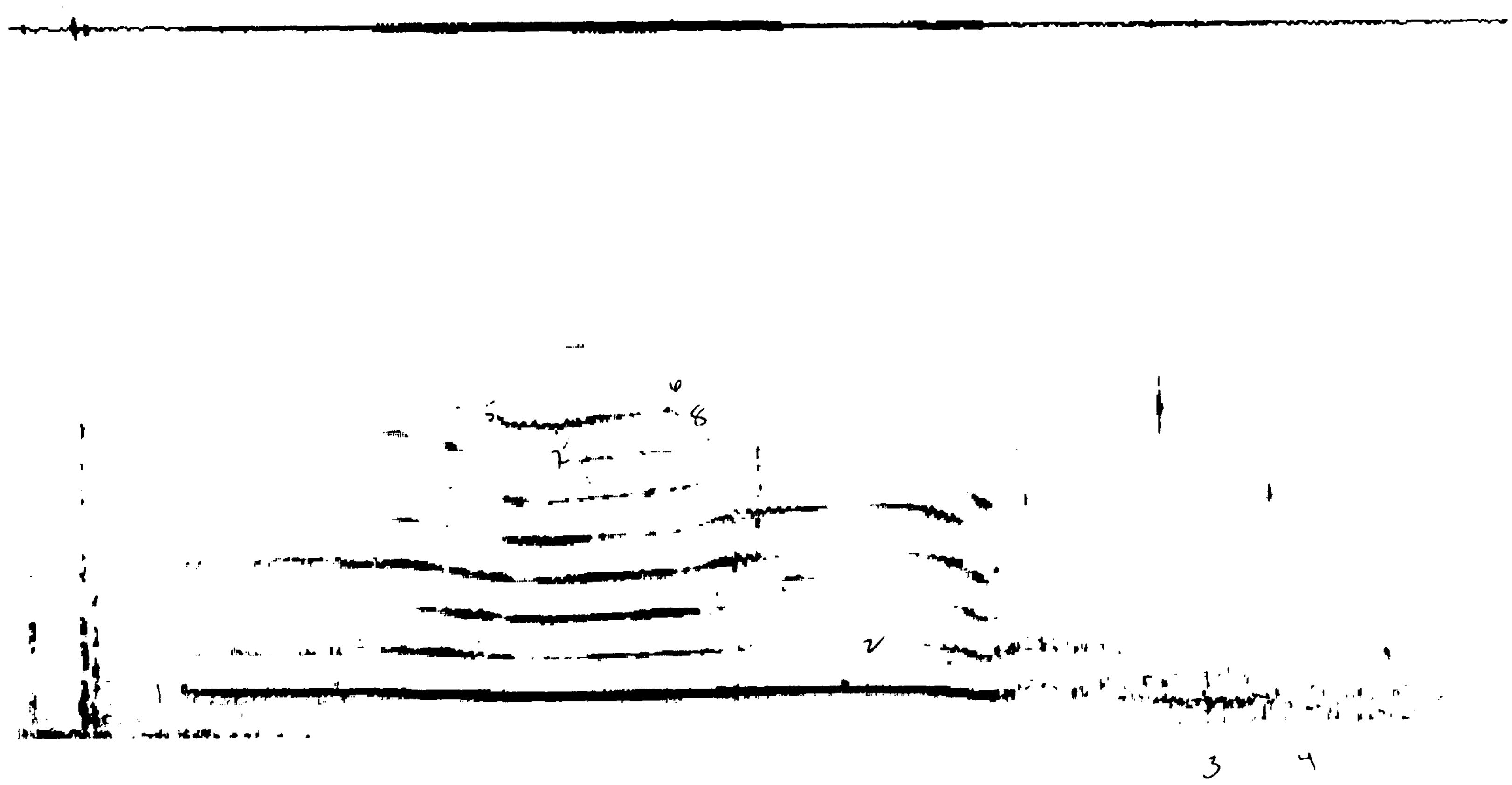
Type Sound: call w/ pulsive tail
mod. tonal

Saved name (log##type#h.ctr)
c:\signal\rw\L49 wca 8h.186

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: 248 has pulsive tail, too
Eg type 2 log 9



Log 10

Right Whale Sound

Trip-Tape-Side-Counter
- 1 - 1 - 186

4kHz 8kHz Other:_______
(circle one)

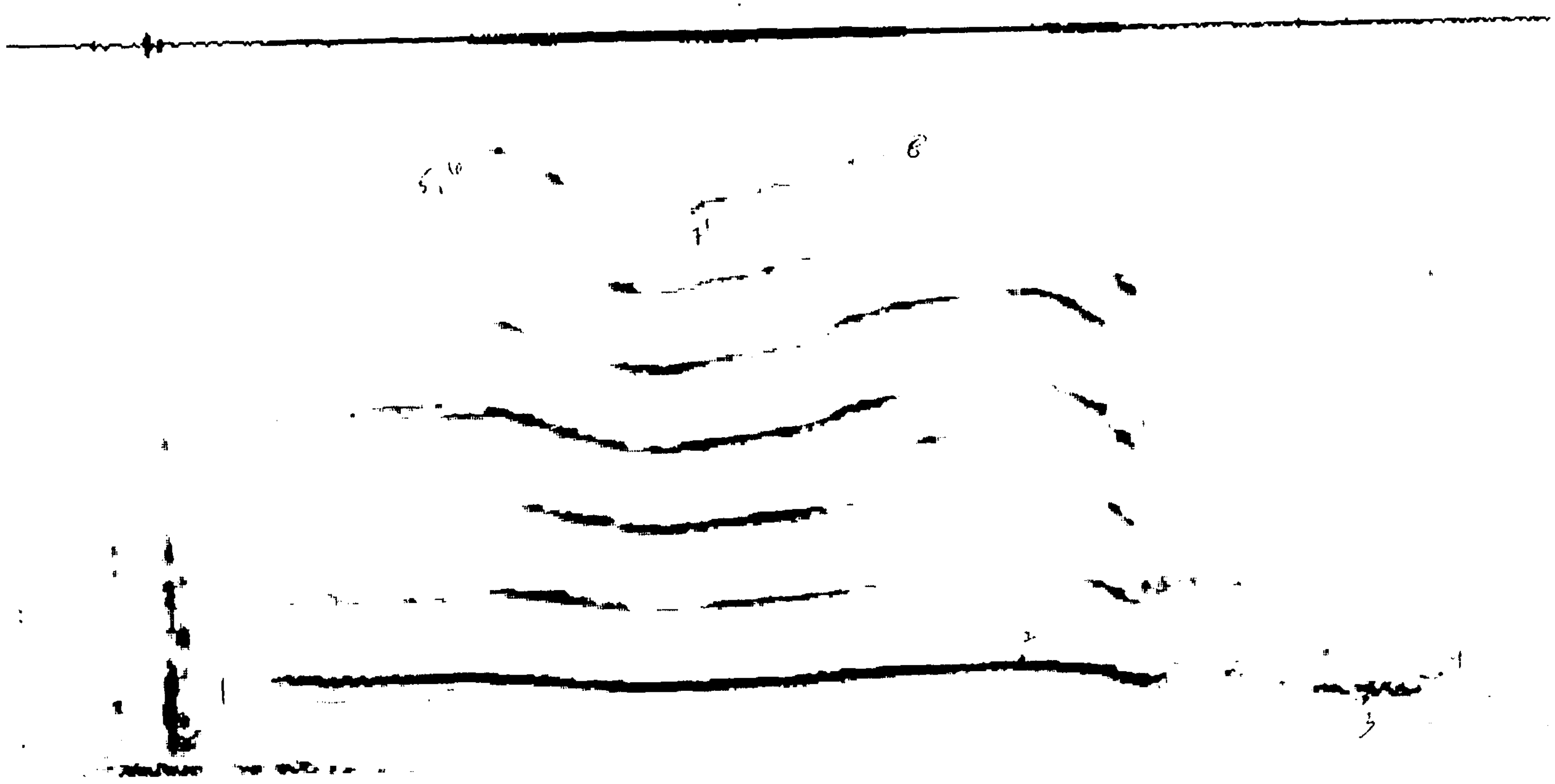
Type Sound: ~~tonal~~ modulating call w/ 10% pulse @ end

Saved name (log##type#h.ctr)
c:\signal\rw\ L49mca4h.186

logfile: RW.6

Standard Settings for files:
length: 3.5 seconds. scroll rate: 6.8 seconds.
spectral gain: -57.00 db spectral range: 11.0 db
8kHz: sample rate: 20,000 Hz frequency resolution: 39.1 Hz
4kHz: sample rate: 10,000 Hz frequency resolution: 19.5 Hz

Comments: tonal, modulating call (w/ slap, end pulsive sound)
tr log is after pulse
Eg type 2 log 10



Appendix IV
Right Whale Vocalization: Numeric Description
by
Dara Wambach

Appendix III

The following describes preliminary use of the RTS sonagraphic system and the notation used in the examples of the numerical descriptions used in the accompanying log data work sheets.

Notes of sample Type Sounds and worksheet, September 6, 1993

Logging-in Type sounds:

With the goal of using numeric frequency and time duration values to describe similarities and differe through RTS (see Engineering Design manual for establishing logfiles). Using the logfile c:\signal\eg points from RTS sound files which I had previously compiled in a blue right whale vocalization catalo most of the sample sounds I indicated on the printouts the points which were logged into egtype.2. T the sound they represent, and with the order in which the information is prompted.

1 left end of primary element
2 highest point of primary
3 lowest point of primary
4 terminal (left) end of primary
5 right side of highest element of sound
6 highest level of sound
7 lowest point of top of sound
8 terminal end of highest sound element

When the location request was repetitive or didn't apply, I often hit Z for zerolog. The marks on the potential for different high/low, etc.. assignments according to the frequency (4 or 8 kHz) at which th information recorded in Egtype.2 are the frequency of the saved file, the rw.6 log number (also an ide sound file name), and type of sound. These entries represent the 20 query limit per logentry.

Coverting logfile to EXCEL:
*copy egtype.2 to egtype.5 (or something similar)
*go into DOS to edit, removing header lines
*bring file into word to create document and even-out all tab spacing (essential for converting log colu
*Pull rwtype2.doc into Excel, convert to rwtype2.xls
*most recent file is b:\rwtype3.xls

In excel:

remove extranneous characters, name columns, make calculation columns for desired informati

RWTYPE3.XLS

A B C D E F G

log #	time primbl	frq primbl	prihigh time	prihigh freq	prilow time	prilow freq
1	1.097	344	2.711	469	1.097	281
2	0.641	344	2.248	453	1.644	313
3	1.757	500	1.773	563	2.158	313
4	1.821	500	1.837	531	2.262	359
5	1.004	531	1.5	656	1.973	344
6	0.828	578	1.348	609	1.798	406
7	0.837	469	1.945	500	2.1	219
8	0.986	438	1.911	500	2.164	188
9	0.426	563	2.042	625	2.969	344
10	0.624	578	2.209	625	3.153	625
11	1.228	375	2.067	469	2.303	156
12	1.59	375	2.45	438	2.664	125
13	1.431	344	1.979	438	2.357	156
14	1.589	375	2.455	438	2.515	156
15	1.522	625	2.557	906	2.749	375
16	0.655	641	1.651	891	1.954	375
17	1.063	188	2.904	344	1.629	0
18	0.617	94	2.387	328	1.102	0
19	0.938	188	2.304	625	1.114	78
20	1.863	125	3.234	625	2.062	63
21	1.346	125	2.183	188	2.467	109
22	1.701	63	2.135	500	2.493	63
23	0.373	109	0	0	0	0
24	1.984	375	2.105	469	2.061	281
25	2.208	359	2.315	453	2.267	313
26	0.423	125	1.185	266	0.746	0
27	1.953	125	2.695	406	2.261	0
28	2.411	16	2.635	78	2.405	47
29	2.017	0	2.242	188	2.017	0
30	1.606	125	2.499	500	1.715	0
31	1.819	156	2.663	469	2.022	31
32	1.034	78	2.145	313	1.786	125
34	0.924	547	0.924	609	1.036	469

1. Connect spreadsheet w/ catalogue sounds
   a) through rwtype3.XLS column A
   log# which is recorded in red in comments section
   b) Also see column S for rw 6 log
   part of name
   c:\signal\rw\L#.xxx .

H (4) I (4) J (5) K (5) L (6) M (6)

prim right time	prime right freq	high left time	high left freq	time highest	freq highest
2.711	375	1.247	4594	1.787	4656
2.253	422	0.683	3969	0.699	3969
2.451	406	1.838	3938	2.082	4156
2.51	438	2.179	3984	2.179	3984
2.943	438	1.032	4688	1.68	4813
2.768	422	1.113	3969	1.113	3969
2.255	375	1.319	5375	1.319	5438
2.418	422	0.991	3984	0.991	3984
3.121	469	1.108	4313	1.628	4250
3.288	625	1.141	3969	1.141	3969
2.615	297	1.338	3594	1.458	3719
2.982	313	1.919	6094	1.919	6094
2.428	219	1.502	4188	1.612	4313
2.592	188	1.671	3797	1.852	3906
2.902	375	1.626	4344	2.497	4844
2.025	422	0.747	3984	0.747	3984
2.916	250	1.629	3344	2.4	3969
2.404	313	1.159	3500	1.667	3891
2.309	594	1.104	3984	1.104	3984
3.24	594	2.11	5156	2.242	5625
2.692	172	1.975	1984	0	0
2.71	313	1.93	4563	0	0
1.823	109	0.514	922	0.514	922
2.105	406	2.023	1719	2.045	1813
2.315	453	2.235	1750	0	0
1.778	0	1.01	359	1.262	406
2.779	375	2.436	531	2.719	1000
2.641	109	2.4	4000	0	0
2.248	94	2.022	7906	0	0
2.554	438	1.814	2094	2.082	2234
2.784	438	2	2094	2.137	2219
2.532	281	1.644	1406	2.156	1641
1.304	531	1.018	3063	1.018	3063

N (7) O (7) P Q R S T U

low high time	low high freq	time high right	freq high right	kHz	rw.6 log	type	prim length
1.488	4500	1.867	4656	8	35	full call	1.614
1.756	3750	1.756	3750	4	35	full call	1.612
2.218	3781	2.327	4125	8	69	full call	0.694
2.278	3797	2.334	3953	4	69	full call	0.689
1.838	4406	2.148	4156	8	61	full call	1.939
1.545	3688	1.77	3953	4	61	full call	1.94
1.38	5344	1.413	5344	8	54	full call	1.418
2.291	3984	2.291	3984	4	54	full call	1.432
1.336	4031	1.645	4250	8	49	full call	2.695
1.596	3594	1.821	3734	4	49	full call	2.664
2.023	3500	2.023	3500	4	53	tail call	1.387
1.919	6094	1.919	6094	8	53	tail call	1.392
1.54	4125	1.683	4250	8	34	tail call	0.997
1.677	3797	1.858	3906	4	34	tail call	1.003
1.687	3406	2.837	4219	8	63	fdif call	1.38
1.927	3984	1.927	3984	4	63	fdif call	1.37
2.761	3125	3.246	3625	8	36	fdif call	1.853
2.324	3156	2.723	3641	4	36	fdif call	1.787
1.216	3844	1.339	3891	4	28	blow	1.371
2.11	5156	2.242	5656	8	28	blow	1.377
0	0	2.287	2031	4	29	blow	1.346
0	0	2.106	4563	8	29	blow	1.009
0.897	594	1.527	594	4	21	low call	1.45
2.023	1688	2.045	1813	8	43	low call	0.121
0	0	2.256	1750	4	110	low call	0.107
1.125	313	1.24	375	4	173	low call	1.355
2.629	531	2.725	1031	8	173	low call	0.826
0	0	2.526	4000	4	456	slap	0.23
0	0	2.055	7906	8	456	slap	0.231
1.836	2094	2.104	2094	4	229	comp c	0.948
2.285	2125	2.345	2125	8	229	comp c	0.965
1.998	1328	2.232	1469	4	177	comp c	1.498
1.074	3016	1.074	3016	4	269	comp c	0.38

V W X Y

highest length	max freq range	when is primary lowest?	prim $\bar{x}$ length by type
0.62	4375	0	
1.073	3656	1.003	
0.489	3843	0.401	
0.155	3625	0.441	
1.116	4469	0.969	
0.657	3563	0.97	
0.094	5219	1.263	
1.3	3796	1.178	
0.537	3906	2.543	full calls
0.68	3344	2.529	1.6697
0.685	3563	1.075	
0	5969	1.074	
0.181	4157	0.926	tailed calls
0.187	3750	0.926	1.19475
1.211	4469	1.227	
1.18	3609	1.299	
1.617	3969	0.566	full diffuse calls
1.564	3891	0.485	1.5975
0.235	3906	0.176	
0.132	5562	0.199	
0.312	1875	1.121	blows
0.176	4500	0.792	1.27575
1.013	922	no fluctuation	
0.022	1532	0.077	
0.021	1437	0.059	
0.23	406	0.323	low calls
0.289	1000	0.308	0.7718
0.126	3953	no fluctuation	slap
0.033	7906	no fluctuation	0.2305
0.29	2234	0.109	
0.345	2188	0.203	
0.588	1516	0.752	compact calls
0.056	2594	0.112	0.94775

Z

prim x low freq
full calls
339.2
tailed calls
148.25
full diffuse calls
187.5
blows
78.25
low calls
118.8
slap
23.5
compact calls
297

Appendix V
Right Whale Observation: Example H250

The following is a collation of a segment of an analyzed observation containing oriented elements of the top seven databases listed in figure 1. The oceanographic data in the form of CTD profiles was collected at a different location that the behavioral data. This preliminary listing is a facsimile of the raw data stream, a section of a 76 min. observation which demonstrates the display capabilities of this simplified approach to multivariable observations.

Header:

Date: 03-31-93
Time: 140356
LORAN: 13904.2/44030.0
Weather: gentle variable, 9°C., 2/10 hi
Vis: unlimited
Cruise: H250
CTD Data: attached verticals
ZPL Density @ sync time +345: 00956/m^3

Data follows(relative time base; letters refer to individual a-c):

Time	Behavior	Vessel	Vocal	Orientation
0011	**flu a**	**igear,0700**		**r=45m;b=150;h=320**
0015	**flu b**			
0016	**1/2flu c**			
0025		**ogear**		
0027			**up2**	
0037		**igear,0400**		
0038			**up2**	
0039			**lo3**	
0043		**ogear**		**04.0/30.8**
0047			**up2**	
0051			**up2?**	
0067			**up2**	
0070			**up1**	
0074			**up2**	
0076			**up2**	
0079			**lo3**	
0083			**up1**	

0087			up2	
0090	swirl			
0099			up2 dist	
0105			up1,slp	
0109			up2	
0113			lo1	
0127			up? dist	
0145	swirl			
0159		igear,0500		04.0/30.9
0172	spt d			
0177	swirl			
0188		ogear		r=50m;b=240
0197			up? dist	
0223			up? dist	
0251			up? dist	
0260			lo1 dist?	
0288			up? dist	
0311	spt ?			
0311	spt a			
0312	spt c	igear 0900		r=130m;b=300;h=010;5kts,090
0315	rol r b			
0317	blog b			
0320	spt a		up? dist	r=35m;b=060;h=150
0325	spt b	ogear		
0326	blog a			
0329	elog a			
0332	bemb a-b			
0333	elog b;kik c?		up?dist	
0333	hup b			
0335	eemb a-b			
0337	spt b			
0345	spt a			
0349	rol r b			
0354				r=45m;b=100;h=?;03.8/30.8
0356	spt b		lo? dist	
0357	spt a			
0359	blog b			
0361	swirl	igear0500		
0364	spt a			
0364	spt c			
0365	spt b;arc c			
0389	flu b			
0397	flu a			
0320	arc c?			